NOMENCLATURE OF WING VEINS AND CELLS

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IDEALLY THE NAMING OF VEINS and the cells between them should be uniform and in at least general agreement; unfortunately, in surveying the literature one soon finds that such is not the case. There are many systems for naming veins and almost as many for cell nomenclature. Each author obviously uses that system most familiar to him, usually disregarding other schemes, and thus adds to the confusion of the reader. This bewilderment is most apparent when a non-lepidopterist attempts to use some of the systems that are purely oriented to Lepidoptera and that bear little or no relationship to the schemes employed for other orders of insects. I therefore present this paper in an attempt to unravel some of the confusion generated by the differences in these diverse systems, but I will also engage in some "evangelism" in behalf of that scheme that I feel is most advantageous.

The references below to the different workers employing the various systems only deal with those works on the New World butterflies — the reconciliation of the schemes used in papers on moths will have to be done by another author.

THE HERRICH-SCHÄFFER SYSTEM

One of the earliest systems for naming veins, and certainly the oldest one that has survived into the relatively modern literature, was devised by Herrich-Schäffer over a century ago and first used in his writings. As shown in Fig. 1, in this system the most anterior forewing vein is the costa (C), the next five are branches of the subcosta (from the anterior one, SC_1, SC_2, SC_3, SC_4 and SC_5), the following two are the *ober*-radius (OR) and *unter*-radius (UR), the next three are branches of the medius (M_3,
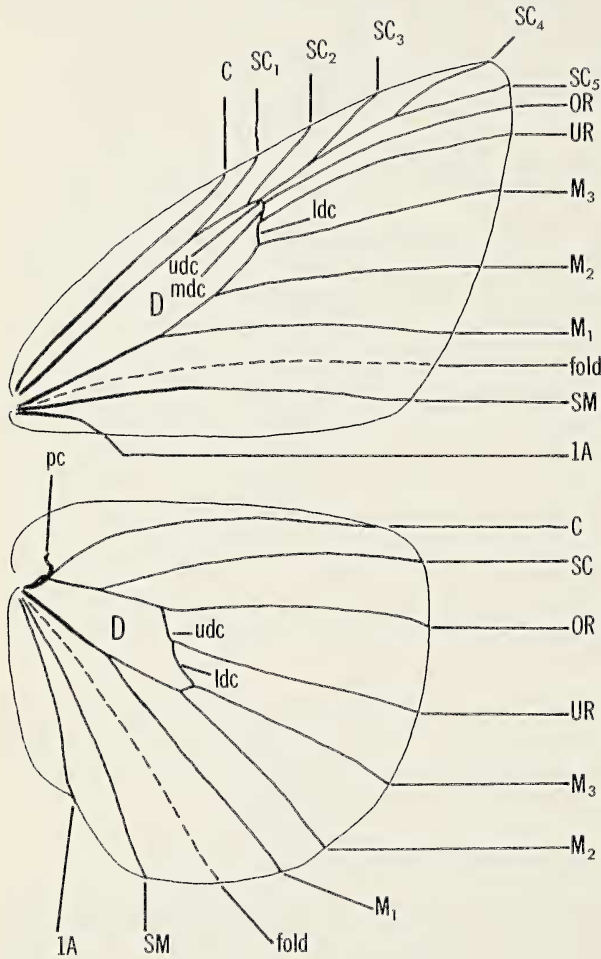
Fig. 1.—Venation of a hypothetical butterfly according to the Herrich-Schaffer system. The abbreviations are explained in the text.

M_2 and M_1, from anterior to posterior; the rationale here being that M_1 arises nearer the base than does M_2, etc.), and the most posterior vein that is present in all butterflies is the sub-medius (SM). If the small vestigial vein posteriad of SM is present, as it is in the Papilionidae, it is known as the first anal vein (1A). The hindwing venation is as follows: the short, spur-like vein near the base and anteriad of the first main vein is the precosta (pc), the anterior main vein is the costa (C), the second the subcosta (SC), the next two the *ober*-radius (OR) and *unter*-radius (UR), the following three the branches of the medius (respectively, M_3, M_2 and M_1), the next one (the most anterior one not connected to the discal cell) the sub-medius (SM) and the most posteriad vein is the first anal (1A). On both wings the anterior vein delimiting the discal cell is the subcosta and the posterior vein the medius. The forewing crossveins between SC_5 and OR, OR and UR, UR and M_3 are the first (upper), second (middle) and third (lower) discocellulars (respectively, udc, mdc and ldc). The hindwing crossveins between SC and OR, OR and UR are the first or upper (udc) and second or lower (ldc) discocellulars, respectively.

There are no provisions for naming cells in this system, except for the discal cell (D) which is the same in all schemes.

Although the Herrich-Schäffer system is not in current usage, it is of interest to American workers since it is employed in those sections of Seitz' *Macrolepidoptera of the World* contributed by Fruhstorfer, Haensch, Röber and in some of Weymer's discussions. This system is also the one used by Godman and Salvin in the *Biologia Centrali-Americana,* and the venation drawings of Ithomiidae in Holland's *Butterfly Book* were taken from another author using the Herrich-Schäffer system.

THE "INDIAN" SYSTEM

The "Indian" system, used chiefly by de Nicéville and Moore in their various writings on the butterflies of the Indian region, affects Americans only peripherally in comparisons of the Old and New World faunas. This system differs very little from that of Herrich-Schäffer: OR and UR of the forewing are designated, respectively, Discoidal 1 and Discoidal 2; hindwing vein SC of Herrich-Schäffer is the first subcostal (SC_1) in the present system, OR is the second subcostal (SC_2), UR is the Discoidal and 1A is the Internal nervule.
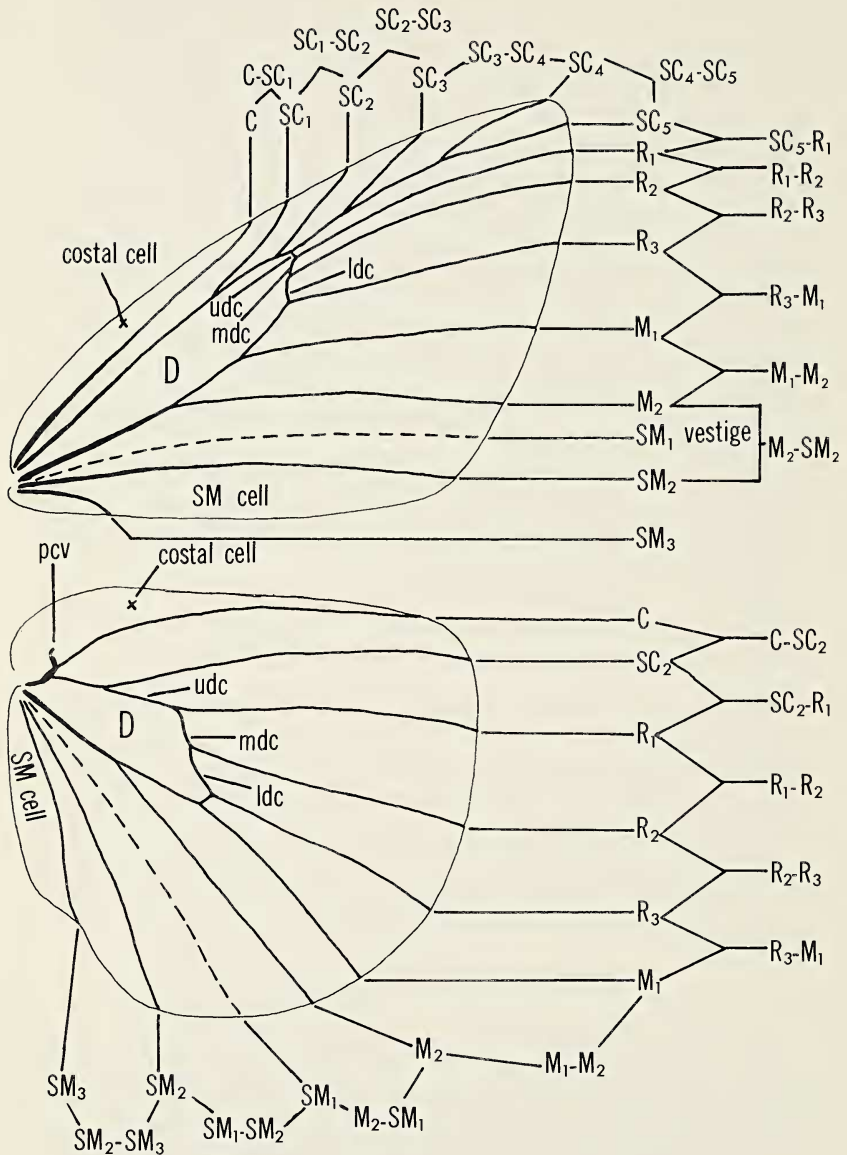
Fig. 2.—Venation and extradiscal cells of a hypothetical butterfly according to the Rothschild-Jordan system. The single symbols represent the names of veins, and the double ones (*i. e.*, M_1-M_2) represent cells, as explained in the text.

THE ROTHSCHILD-JORDAN SYSTEM

The Rothschild-Jordan system (Fig. 2), based in part on the Herrich-Schäffer system, was the most comprehensive one proposed to its time. In this scheme the most anterior forewing vein is again the costa (C), the next five branches of the subcosta (SC_1, SC_2, SC_3, SC_4 and SC_5, from anterior to posterior), the next three are branches of the radius (R_1, R_2 and R_3, from the most anteriad), the following two branches of the medius (M_1 the anterior and M_2 the posterior), and those veins arising posteriad of the cell are the submedians (SM); the most anterior of these (SM_1) is considered absent and represented by only a fold, the one present in all Lepidoptera is SM_2 and the tiny, posterior spur is SM_3. The forewing crossveins between SC_5 and R_1, R_1 and R_2, R_2 and R_3 are, respectively, the upper (udc), middle (mdc) and lower (ldc) discocellulars. On the hindwing the short basal spur anterior to the main veins is the precostal vein (pcv), the anterior main vein is the costa (C), the second the second subcosta (SC_2, SC_1 being considered absent), the next three are branches of the radius (from the anterior one, R_1, R_2 and R_3), the following two are branches of the medius (M_1 anteriad and M_2 posteriad) and those veins arising posteriad of the discal cell are the submedians (SM): the anterior SM_1 is only a fold in most butterflies, whereas the middle SM_2 and the posterior SM_3 are always present. The upper (udc), middle (mdc) and lower (ldc) disocellulars delimit and end of the discal cell between veins SC_2 and R_1, R_1 and R_2 and R_2 and R_3, respectively

The naming of the spaces between the veins outside the discal cell (D) was formalized in the Rothschild-Jordan system with great precision. The cells are named for the veins bounding them, so that the space between veins M_1 and M_2 is denoted M_1-M_2, for example. The cells anteriad of C and posteriad of the last SM are, respectively, the costal cell and the SM cell.

The Rothschild-Jordan system was used widely by authors in the last decade of the last century and the first thirty years of this one. In works pertaining to the American butterflies Holland adopted the system in *The Butterfly Book* (with the exception of the venation drawings of ithomiids mentioned in the discussion of the Herrich-Schäffer system), and the Rothschild-Jordan scheme is employed in those parts of Seitz authored
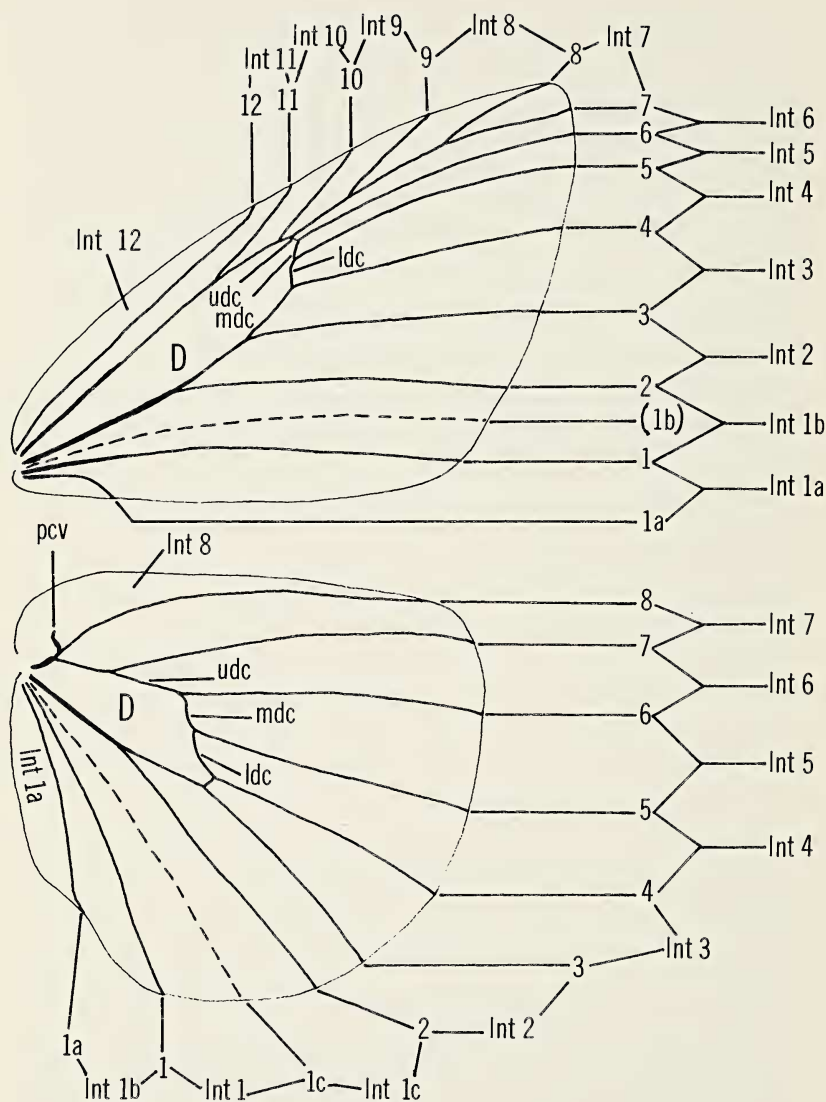
Fig. 3.—Venation and extradiscal cells of a hypothetical butterfly according to the "English", or numerical, system. Those symbols preceded by "Int" refer to the cells, and the numbers alone refer to the veins, as explained in the text.

by Seitz, Jordan and Draudt. Naturally, the system is employed in Rothschild and Jordan's revision of the American *Papilio*.

THE "ENGLISH", OR NUMERICAL, SYSTEM

The "English", or numerical, system (Fig. 3) is a totally artificial system whose major advantage is its great simplicity. In this scheme the main veins of both wings are named from the most posterior to the most anterior: hence, all butterflies have veins 1-12 on the forewing and veins 1-8 on the hindwing. The only source of confusion concerning the nomenclature of veins is in the designations of those which arise posterior to the discal cells (D) of both wings. On the forewing the vestigial vein posteriad of vein 1 is denoted as 1a (the fold between veins 1 and 2 represents the primitive vein 1b), and on the hindwing the possible veins posteriad of the cell are veins 1c, 1 and 1a, from the cell to the inner margin. The hindwing precostal vein (pvc) of other systems bears no special designation in the "English" system and the discocellular veins (udc, mdc and ldc) of both wings are as in the Rothschild-Jordan system.

The naming of the extradiscal spaces (Int.) is equally simple: the cells are named for the veins *posteriad* of them — thus the cell between veins 6 and 7 is known as Int. 6. The only apparent inconsistency concerns the spaces on either side of vein 1 of both wings. The cell anteriad of forewing vein 1 is Int. 1b, and the one posterior to vein 1 is Int. 1a. The hindwing cells from vein 2 and the inner margin are Int. 1c, Int 1 and b respectively.

The numerical system is followed by most British and some American writers. It is chiefly of interest to workers on American butterflies because of its use by Weymer in Seitz (but *not* in his discussions where he uses the Herrich-Schäffer system) and by Evans in his catalogues of the American Hesperiidae.

THE COMSTOCK-NEEDHAM SYSTEM

The Comstock-Needham system (Fig. 4) is followed by most present-day American writers, although there are modifications of it utilized by one or another. This scheme is based on the venation of all insects, not just Lepidoptera, and thus has more universal application than other systems. The most anterior forewing vein is denoted the subcosta (Sc), the true costal vein being lost in at least the butterflies, the next five are branches
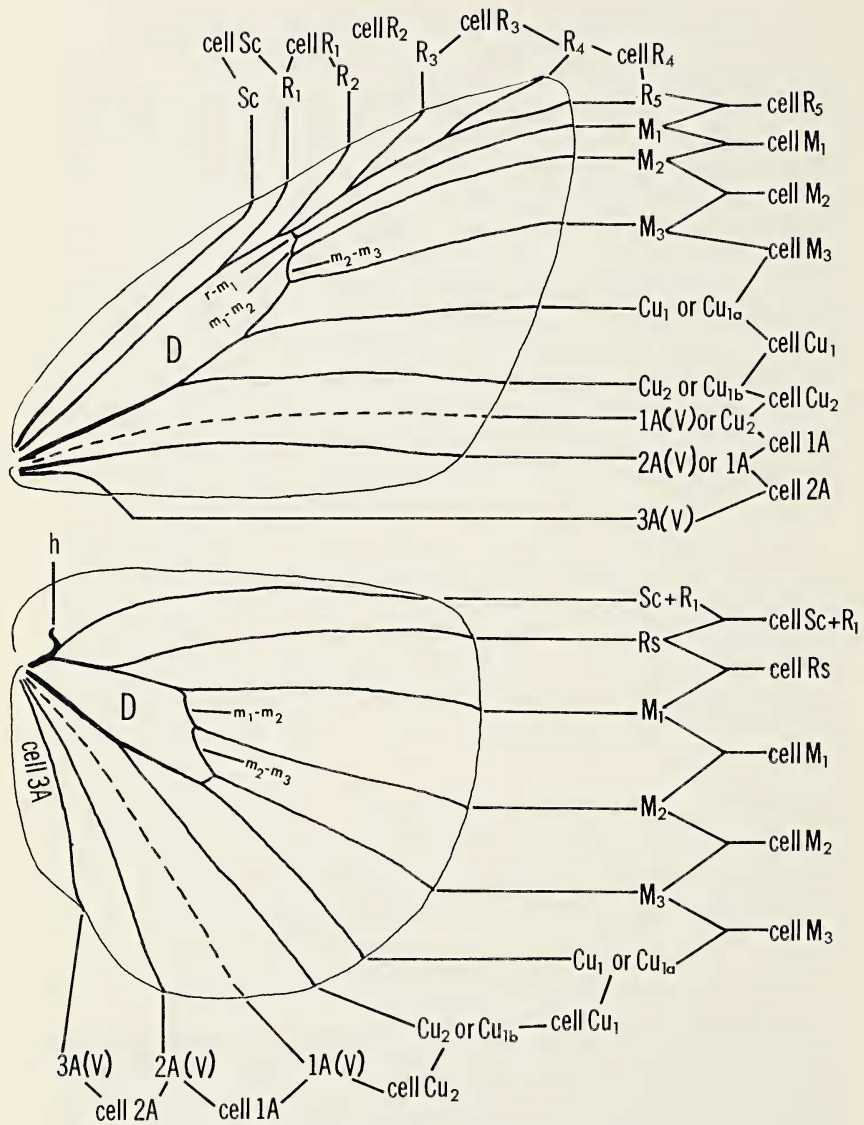
Fig. 4.—Venation and extradiscal cells of a hypothetical butterfly according to the Comstock-Needham system. The symbols are explained in the text.

of the radius (R_1, R_2, R_3, R_4 and R_5, from the anterior to the posterior one), the next three are branches of the medius (from the anterior, M_1, M_2 and M_3), the following two are branches of the cubitus (from the anterior, Cu_1 and Cu_2, or according to some authors, Cu_1 and Cu_1, respectively), and those veins arising posteriad of the discal cell are the anal veins (A): the one present in all butterflies is known as 2A (it also may be denoted 1A, depending on whether the fold posteriad of the last cubital vein is considered the remnant of 1A or of Cu_2, and this depending on the interpretation of the cubital veins). The anal veins are also known as vannal veins, in which case they are abbreviated 1V, 2V, etc. The spur vein anteriad of the hind-wing main veins (the precostal vein of other systems) is the humeral vein (h), the anterior main vein may be considered as the subcostal vein and the first radial branch ($Sc+R_1$), the second main vein is the radial sector (the fusion of all of the radials except R_1 and abbreviated as Rs, *not* R_5 as stated by some authors), then come the three branches of the medius (from the anterior to the posterior, M_1, M_2 and M_3), and the last two veins arising from the cell are branches of the cubitus (again Cu_1 or Cu_1 the anterior one and Cu_2 or Cu_1 the posterior one). The anal (or vannal) veins arise posteriad of the cell and are denoted as 1A (1V), usually absent in butterflies, 2A (2V) and 3A (3V) from the discal cell to the inner margin. The stalk veins delimiting the discal cells of both wings are anteriorly the radius (R) and posteriorly the cubitus (Cu). Many authors still refer to the crossveins at the end of the discal cells as the upper (udc), middle (mdc) and lower (ldc) discocellulars, but the system is explicit in that these crossveins are named for the veins they connect, so that the crossvein between M_1 and M_2 is denoted m_1-m_2. Note that the initials are in lower case in this instance.

There are at least two methods of designating the extra-discal cells in the current literature: the discal cell (D) is the same in both. Both Klots and the Ehrlich in their books on North American butterflies name these cells for the veins forming their *anterior* boundaries (Fig. 4), so that the cell bounded by veins M_1 and M_2 is cell M_1. Other authors use a system of naming these spaces similar to that proposed by Rothschild and Jordan (Fig. 5), using the names of both boundary veins to designate a cell; thus, the cell between veins M_1 and M_2 is space M_1-M_2 (note that in this instance the symbols are capitalized to avoid confusion with the terminology for crossveins).
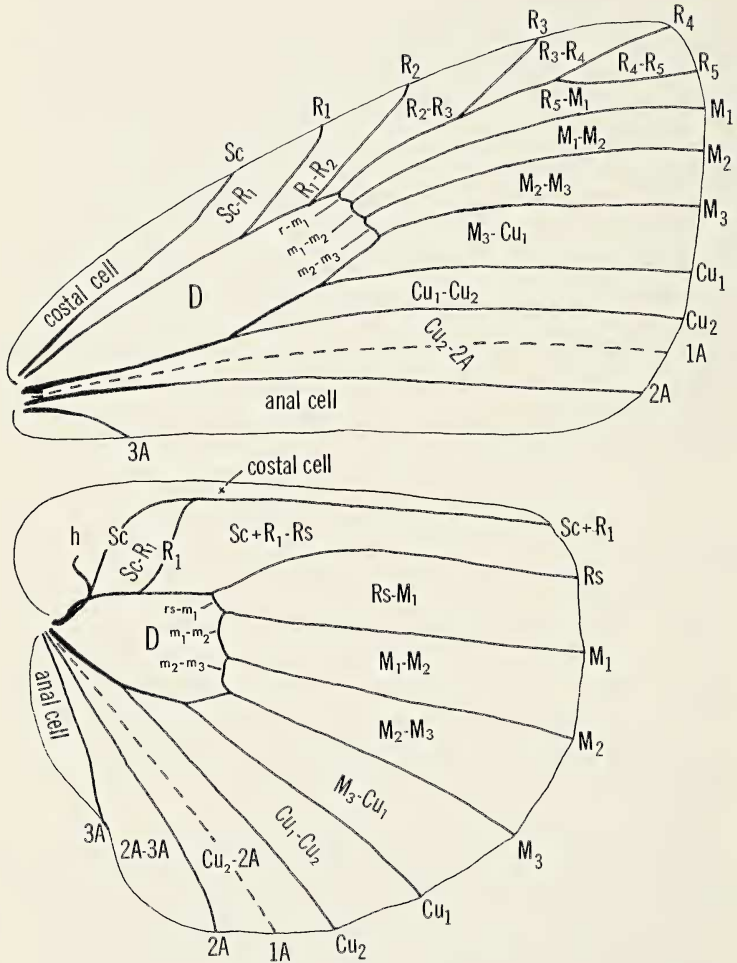
Fig. 5.—Wings of a hypothetical butterfly showing the proposed uniform system of nomenclature for veins and extradiscal cells. The symbols are explained in the text.

SPECIAL STRUCTURES

In the discussion of the various systems I have mentioned the small spur vein at the anterior basal part of the hindwing, the precostal vein (pc, pcv) of older systems or the humeral vein (h) of the Comstock-Needham system. Zeuner (1943, *Ann. Mag. Nat. Hist.*, 11/10: 290) considered that this vestigial vein represented either the costa (C) or the first branch of the primitive subcosta (Sc_1), but other authors have not been certain or have considered that this vein is unrelated to the main veins and arose *de novo* in Lepidoptera.

In a few groups of butterflies, for example, the Brassolinae the proximal part of the anterior main vein of the hindwing is divided into two members (Fig. 5). There is no provision in any of the systems to name these two veins, except the Comstock-Needham system where the anterior member is Sc and the posterior R_1. The more or less triangular cell formed by these two veins and the anterior boundary of the discal cell is called the precostal, prediscoidal or simply the basal cell in most systems, but may be designated as cell Sc-R_1 in that persuasion of the Comstock-Needham system advocating the naming of the cells for the veins bounding them.

DISCUSSION

The Herrich-Schäffer, "Indian" and Rothschild-Jordan systems simply are not applicable in view of modern evidence as to the identity of veins. Since these systems were based on Lepidoptera only, they are not applicable for other insect groups. The synthetic "English" system is not only inapplicable to other groups of insects but also is not completely reliable for Lepidoptera. This system was devised primarily for butterflies and is singularly fitted only for them, but the scheme may fail when applied to some moth groups that have more or fewer veins. This system is in wide use in the moths, largely because it was employed by pioneer Heterocera workers such as Meyrick and Hampson, but at least the latter author had problems in applying the system uniformly throughout his work. A system, then, to be most valuable must offer the opportunity to draw homologies between the venation patterns of diffuse groups.

The remaining system, the Comstock-Needham system, is the only relatively natural one that can be used not only for Lepidoptera but also for other groups of insects, and, as such, is the

most useful to entomologists. I will not address myself to the problems of cubital and anal vein nomenclature; these are matters for individual workers to decide (which scheme is being employed soon becomes evident from reading a paper, anyway). The use of the Comstock-Needham system enables anyone, lepidopterist or not, to know just what vein is being referred to in a paper on Lepidoptera. Since lepidopterists are also entomologists, and since the Comstock-Needham system is *the* system that is recognized by entemologists of all specialties, it would be best if lepidopterists adopted that system used by the great majority of other entomologists.

The nomenclature of the extradiscal cells is somewhat more difficult. The scheme promoted by Klots and the Ehrlich of naming these cells for the veins *anteriad* of them is in direct opposition to the "English" system in which the cells are named for the veins posteriad, and a person familiar with one system will almost invariably misinterpret the other. A non-lepidopterist will incorrectly interpret such notations half the time, if indeed, he can decipher the numerical system at all. By contrast, naming the cells for the veins bounding them removes any confusion as to just what cell is under discussion. This rationale is not new, having originated with Rothschild and Jordan before the turn of the century, but this idea has been more or less ignored recently. However, because of its absolute clarity it seems the best solution to the problem of accurately denoting cells.

An example of this preferred system for naming veins and cells is given in Fig. 5.

ACKNOWLEDGMENTS